UNITED STATES DEPARTMENT OF AGRICULTURE

DEPARTMENT BULLETIN No. 1205

Washington, D. C. ▼ January 25, 1924

DUSTING AND SPRAYING PEACH TREES AFTER HARVEST FOR CONTROL OF THE PLUM CURCULIO.[1]

By Oliver I. Snapp, Entomologist, and C. H. Alden, Scientific Assistant, Fruit Insect Investigations, Bureau of Entomology.

CONTENTS.

During the last four years (1919–1922) post-harvest dusting experiments have been conducted in commercial peach orchards in the South to ascertain whether effective work can be done in destroying adult curculios in the late summer or early fall when for lack of fruit the beetles are forced to feed to a great extent on the foliage. During one season also several plats were sprayed, in order to compare the effectiveness of sprays with that of dusts. The information obtained for the four consecutive seasons showed that the adult curculios can be materially reduced in the early fall by making post-harvest applications of arsenate of lead to the trees before the beetles leave them to hibernate.

During the 1921 and 1922 seasons this work was conducted in the peach belt of Georgia, in the vicinity of Fort Valley, where the curculio infestation for several years had been much more severe than elsewhere in the South. The work during the two previous years had been conducted in Mississippi. Since the results obtained during the last two seasons were the more complete and confirmed the results of the work conducted in Mississippi, only the data from the 1921 and 1922 experiments are discussed in detail in this bulletin.

[1] *Conotrachelus nenuphar* Hbst.; order Coleoptera, family Curculionidae.

62130°—24—Bull. 1205——1

RESULTS OF EXPERIMENTS AT FORT VALLEY, GA., IN 1921.

The 1921 post-harvest experiments were conducted in an 8-year-old Elberta orchard. The trees had made fairly good growth, which was uniform over the entire orchard, except at one end, where the soil was not so fertile. This orchard was at least 300 yards from the nearest wooded area, and there were no particularly good hibernating quarters near by for the beetles, except on one side, where the weeds and brush had been allowed to grow along a railroad right-of-way. The curculio proved to be very abundant in this orchard and along with secondary brown-rot infections had made unmerchantable a large part of the fruit crop, which was harvested a few weeks before these experiments began. As many as 46 curculios were found on a single tree, and the average number per tree in the entire orchard was high.

The orchard of nearly 1,500 trees was divided into three blocks as nearly equal in size as practicable. Plat 1 contained 504 trees and received two dust applications. Plat 2 also contained 504 trees and received one dust application. Plat 3 contained 479 trees and was left untreated throughout the experiment as a check. Fifty trees were tagged in different parts of each plat, and these were jarred regularly every other morning, to obtain data on the abundance of the curculios on the several plats. Twenty of these trees were selected in the center of each plat, and three blocks of 10 trees each around the sides. (See fig. 1.) In the entire orchard, therefore, there were 150 record trees, 80 of which were jarred one morning and 70 the next, throughout the course of the experiment. Jarring operations began at sun-up each morning, in order to complete the work before the beetles became active.

JARRING BEFORE DUSTING.

All of the record trees in each plat were jarred twice before any dust was applied, in order to ascertain the degree of the infestation on each plat at the beginning of the experiment. (Pl. I, figs. 1 and 2.) Table 1 gives the number of beetles collected from the several plats before dusting:

TABLE 1.—*Number of curculios collected before dusting, 1921.*

Date.	Plat.			Date.	Plat.		
	1	2	3		1	2	3
	Beetles.	*Beetles.*	*Beetles.*		*Beetles.*	*Beetles.*	*Beetles.*
Aug. 8	.....	.....	214	Aug. 11	186	311	.....
Aug. 9	164	286	.....				
Aug. 10	.....	.....	321	Total	350	597	535
				Average per tree	3.50	5.97	5.35

The number of beetles collected from the 150 record trees in four days was 1,482. The infestation was somewhat lighter on plat 1 than on the other two plats. This was perhaps due to the fact that the trees in plat 1 were smaller than the others, and the further fact that the foliage was not so good, because the soil was less fertile in that part of the orchard. The average number of beetles per tree in each plat before dusting was found to be as follows: Plat 1, 3.5 beetles; plat 2, 5.97 beetles; plat 3, 5.35 beetles.

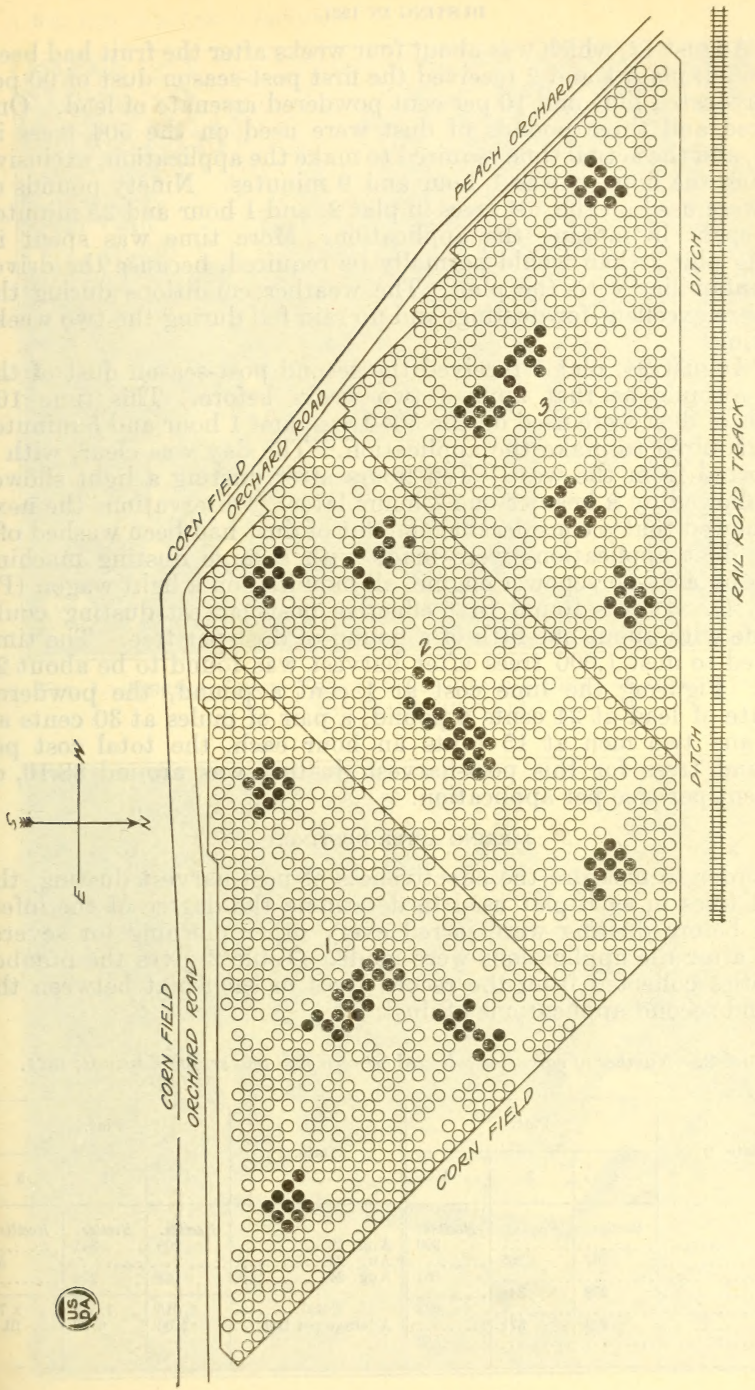

FIG. 1.—Elberta peach orchard at Fort Valley, Ga., in which after-harvest dusting experiments were conducted in 1921. The circles indicate bearing trees, those that were jarred being shown in solid black. Plat 1 was dusted once, plat 2, dusted twice, and plat 3, check.

DUSTING IN 1921.

On August 12, which was about four weeks after the fruit had been harvested, plats 1 and 2 received the first post-season dust of 90 per cent hydrated lime and 10 per cent powdered arsenate of lead. One hundred and three pounds of dust were used on the 504 trees in plat 1, and the actual time required to make the application, exclusive of filling the hopper, was 1 hour and 9 minutes. Ninety pounds of dust were used on the 504 trees in plat 2, and 1 hour and 25 minutes were spent in making the application. More time was spent in dusting plat 2 than would normally be required, because the driver was unfamiliar with the plat. The weather conditions during the day were excellent for dusting, and no rain fell during the two weeks following.

On August 24, plat 1 received the second post-season dust of the same formula as that applied two weeks before. This time 106 pounds of dust were used on the 504 trees, and 1 hour and 5 minutes were required to make the application. The day was clear, with a light wind from the west. Ten hours after dusting a light shower fell, followed by a heavier one 7 hours later. Observations the next day showed that a considerable amount of dust had been washed off.

The dust applications were made with a large dusting machine driven by a 3½-horsepower engine, all mounted on a light wagon (Pl. II, fig. 1). It was found that effective post-harvest dusting could be done with about one-fifth of a pound of dust per tree. The time required to dust 1,000 trees after harvest was found to be about 2½ hours. Figuring the lime cost at 1 cent a pound, the powdered arsenate of lead at 24 cents a pound, a pair of mules at 30 cents an hour, and two men at 15 cents an hour each, the total cost per thousand trees for this post-harvest dusting was around $8.10, or 0.81 cent per tree per application.

JARRING AFTER DUSTING.

In order to measure the effectiveness of post-harvest dusting, the record trees in each plat used to determine the degree of the infestation before dusting were jarred every other morning for several weeks after the applications were made. Table 2 gives the number of beetles collected from the record trees in each plat between the first and second applications of dust.

TABLE 2.—*Number of curculios collected between first and second dustings, 1921.*

Date.	Plat.			Date.	Plat.		
	1	2	3		1	2	3
	Beetles.	*Beetles.*	*Beetles.*		*Beetles.*	*Beetles.*	*Beetles.*
Aug. 13			399	Aug. 22	206	311	
Aug. 15	167	265		Aug. 23			590
Aug. 16			561	Aug. 24	161	278	
Aug. 17	252	348					
Aug. 18			623	Total	1,015	1,573	2,725
Aug. 19	229	371		Average per tree	4.06	6.29	10.90
Aug. 20			552				

The five collections made from the 50 record trees in each plat from August 13 to August 24, therefore, showed the presence of an average

FIG. 1.—JARRING PEACH TREES TO ASCERTAIN DEGREE OF INFESTATION BY THE PLUM CURCULIO.

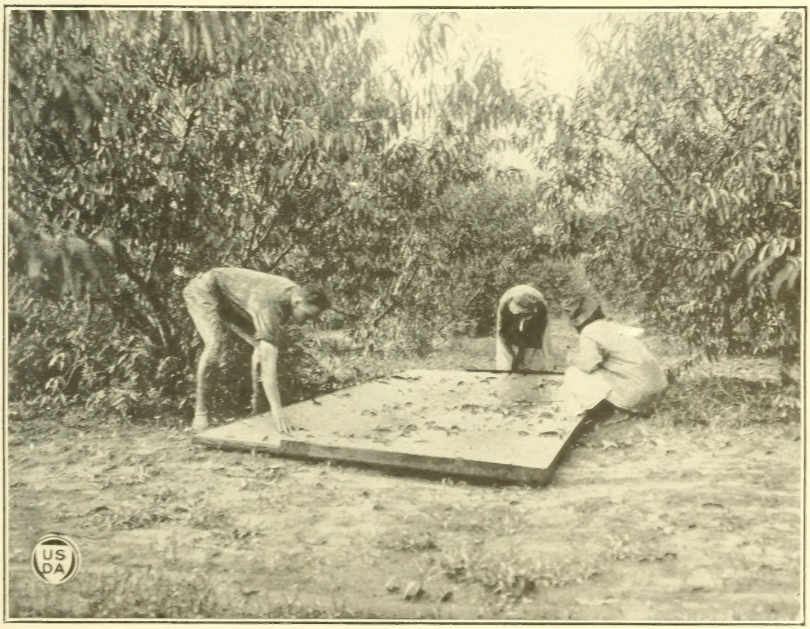

FIG. 2.—COLLECTING CURCULIOS JARRED FROM PEACH TREES.

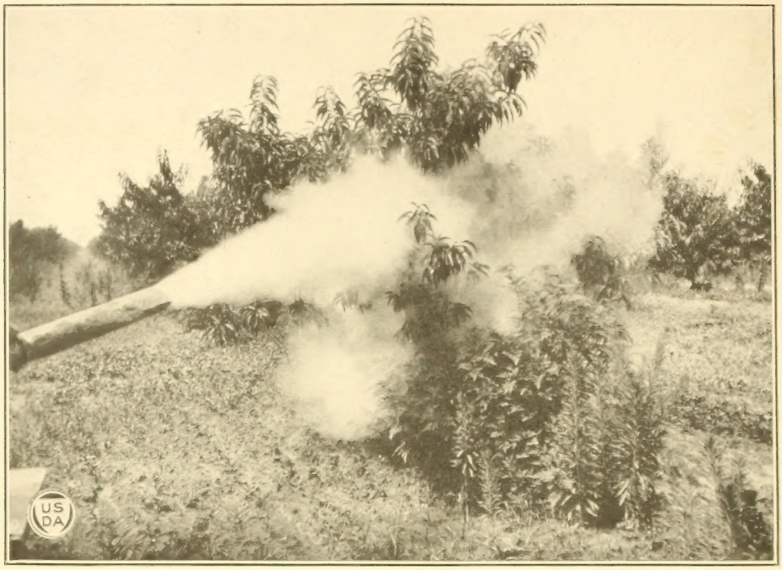

FIG. 1.—DUSTING PEACH TREES WITH A LARGE DUSTER.

FIG. 2.—FEEDING MARKS OF PLUM CURCULIO ON PEACH FOLIAGE SEVERAL WEEKS AFTER PEACH HARVEST.

of 4.06 beetles per tree on plat 1, 6.29 beetles per tree on plat 2, and 10.9 beetles per tree on plat 3, for the period. Plat 1 had increased 0.56 beetle per tree, plat 2 had increased 0.32 beetle per tree, and plat 3 had increased 5.55 beetles per tree after the first dusting was applied to plats 1 and 2. Plat 3, the check plat, had, therefore, 2.04 times as many beetles present per tree during the period August 13 to 24 as during the period before these dates. This rapid increase was due to second-generation adults, which were making their appearance in numbers at that time. The figures above show that the application of dust applied about four weeks after fruit harvest prevented a marked increase in the number of adults. Owing to the heavy emergence of second-generation curculios during the month of August, the increase in the number of beetles collected from each of the plats that were dusted would have been very heavy had it not been for the dusting. The dust held the infestation about constant throughout the period.

Plat 1 received the second application of dust on August 24. During the period from August 26 to September 4, four collections were made on each plat. Table 3 gives the number of beetles collected from the record trees in each plat during the period following the second application of dust to plat 1 until the close of the experiment.

TABLE 3.—*Number of curculios collected during the period following second dusting, 1921.*

Date.	Plat.			Date.	Plat.		
	1	2	3		1	2	3
	Beetles.	*Beetles.*	*Beetles.*		*Beetles.*	*Beetles.*	*Beetles.*
Aug. 26	.....	.....	474	Sept. 2	.....	.....	202
Aug. 27	152	259	.....	Sept. 3	74	92	.....
Aug. 29	.....	.....	426				
Aug. 30	145	270	.....	Total	467	756	1,356
Aug. 31	.....	.....	254	Average per tree	2.34	3.78	6.78
Sept. 1	96	135	.....				

These four collections showed the presence of an average of 2.34 beetles per tree on plat 1, 3.78 beetles per tree on plat 2, and 6.78 beetles per tree on plat 3. These figures show for this period a decrease in the number of beetles on plats 1 and 2, and an increase on plat 3, as compared with the number of beetles per tree before any dust was applied.

Table 4 gives the total number of beetles collected from the 50 record trees in each plat during the entire period of the experiment.

TABLE 4.—*Number of curculios collected during the entire period following first dusting, 1921.*

Date.	Plat.			Date.	Plat.		
	1	2	3		1	2	3
	Beetles.	*Beetles.*	*Beetles.*		*Beetles.*	*Beetles.*	*Beetles.*
Aug. 13	.....	.....	399	Aug. 26	.....	.....	474
Aug. 15	167	265	.....	Aug. 27	152	259	.....
Aug. 16	.....	.....	561	Aug. 29	.....	.....	426
Aug. 17	252	348	.....	Aug. 30	145	270	.....
Aug. 18	.....	.....	623	Aug. 31	.....	.....	254
Aug. 19	229	371	.....	Sept. 1	96	135	.....
Aug. 20	.....	.....	552	Sept. 2	.....	.....	202
Aug. 22	206	311	.....	Sept. 3	74	92	.....
Aug. 23	.....	.....	590				
Aug. 24	161	278	.....	Total	1,482	2,329	4,081
Aug. 25	.....	.....	.....	Average per tree	3.29	5.18	9.07

During the time this work was under way, about 75 per cent more beetles were collected from plat 3, which received no treatments, than from plat 2, one of the treated plats. This is very interesting, since Table 1 shows that plat 2 had a heavier curculio infestation than plat 3 before any dust was applied. The average number of beetles per tree at the close of the experiment in each plat was found from Table 4 to be as follows:

	Beetles per tree.
Plat 1 (dusted Aug. 12 and 24)	3.29
Plat 2 (dusted Aug. 12)	5.18
Plat 3 (no treatment)	9.07

Comparing with Table 1, the average decrease on plat 1 was 0.21 beetle per tree, the average decrease on plat 2 was 0.79 beetle per tree,

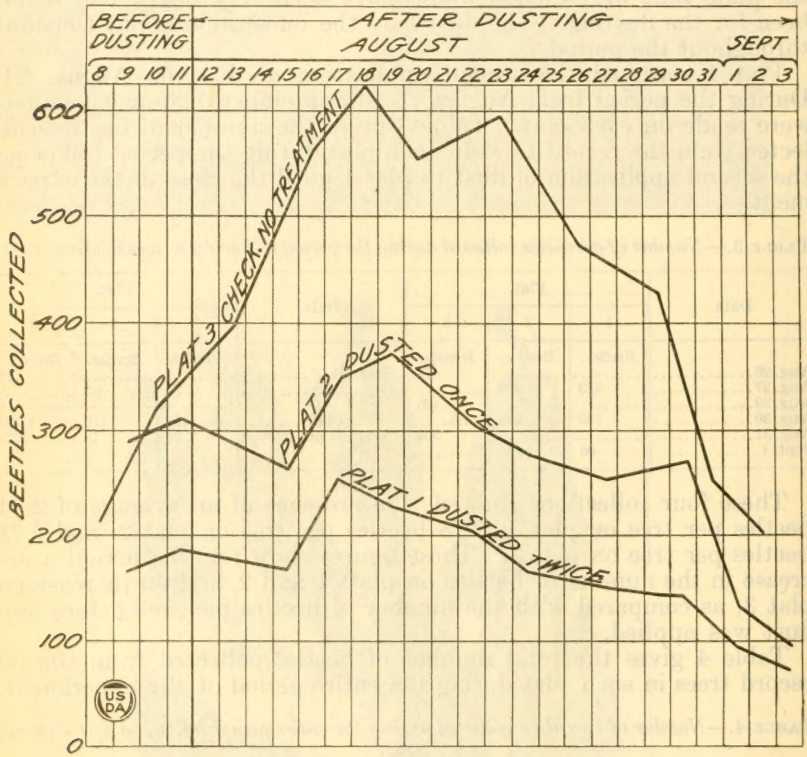

FIG. 2.—Number of plum curculios collected on dusted and check plats, 1921.

and the average increase on plat 3 was 3.72 beetles per tree. (See fig. 2 for graphic comparison of the infestation on the three plats.)

Table 5 gives the summary of results of the field experiments in 1921.

TABLE 5.—*Summary of results from post-harvest dusting, 1921.*

Period.	Average number of beetles per tree.		
	Plat 1 (dusted twice).	Plat 2 (dusted once).	Plat 3 (not dusted).
	Beetles.	*Beetles.*	*Beetles.*
Before dusting	3.50	5.97	5.35
Between first and second dustings	4.06	6.29	10.90
Increase [1]	.56	.32	5.55
From second dusting to close of experiment	2.34	3.78	6.78
Decrease or increase [1]	1.16	2.19	[2] 1.43
Entire period following first dusting	3.29	5.18	9.07
Decrease or increase [1]	.21	.79	[2] 3.72
	Per cent.	*Per cent.*	*Per cent.*
Per cent of decrease or increase [1]	6.00	13.23	[2] 69.53

[1] Compared with period before dusting. [2] Increase.

The second application to plat 1 was in all probability ineffective, owing to the fact that a heavy rain fell soon after the dust was applied, washing off a quantity of the material. In the summary of results the figures on percentage decrease or increase of beetles per tree in each plat show that the increase on the check or untreated plat was enormous. This was due, as stated before, to the heavy emergence of second-generation adults soon after the first dusting was given to plats 1 and 2. The results obtained on the check plat show that, while the dust did not materially decrease the number of beetles during the course of the experiment, it did prevent the heavy increase from the emergence of second-generation adults which would have occurred had the dust not been applied.

RESULTS OF INSECTARY WORK IN 1921.

Considerable insectary work was done in conjunction with the field experiments. Adult curculios collected from the different plats were brought to the insectary daily and kept under observation in battery jars. About 2 inches of moist sand was placed in the bottom of each jar, and the jar was covered with cheesecloth. Fresh peach foliage was added as needed. The curculios with foliage from the several plats were confined in separate jars to determine the killing effect of the poison. The beetles with foliage from the dusted plats were, of course, checked against those from the untreated plat. Ten beetles were confined in each jar, and there were 9 jars for each plat (27 jars in all). Thus 90 curculios from each of the three plats were collected between August 15 and September 3, and daily examinations were made for records on mortality. Table 6 gives the daily record of the mortality of the beetles.

TABLE 6.—*Mortality of confined curculios fed peach foliage from experimental plats, 1921.*

PLAT 1. DUSTED TWICE.

Number of beetles.	Date collected.	Number that died.																																		Number alive Sept. 24.
		Aug. 19.	Aug. 20.	Aug. 21.	Aug. 22.	Aug. 23.	Aug. 24.	Aug. 25.	Aug. 26.	Aug. 27.	Aug. 28.	Aug. 29.	Aug. 30.	Aug. 31.	Sept. 1.	Sept. 2.	Sept. 3.	Sept. 4.	Sept. 5.	Sept. 6.	Sept. 7.	Sept. 8.	Sept. 9.	Sept. 10.	Sept. 11.	Sept. 12.	Sept. 13.	Sept. 14.	Sept. 15.	Sept. 16.	Sept. 17.	Sept. 18.	Sept. 19.	Sept. 20.	Sept. 21.	Sept. 22.	Sept. 23.	Sept. 24.	
10	Aug. 15	1	...	1	...	1	2	1	1	1	1	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
10	Aug. 17	...	...	...	1	...	2	2	2	...	...	.....	1	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
10	Aug. 19	...	...	...	...	...	...	...	...	...	2	2	3	.....	1	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
10	Aug. 22	...	...	...	...	...	1	...	...	1	...	.....	...	.....	.....	3	2	1	1	...	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
10	Aug. 24	...	...	...	...	...	...	...	...	...	...	.....	2	.....	1	2	.....	.....	3	1	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
10	Aug. 27	...	...	...	...	...	...	...	...	...	...	.....	...	.....	.....	1	.....	.....	3	2	.....	2	.....	.....	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
10	Aug. 30	...	...	...	...	...	...	...	...	...	...	.....	...	.....	.....	.....	.....	.....	1	1	2	...	1	1	.....	.....	.....	.....	.....	1	.....	2	1	.....	.....	.....	.....
10	Sept. 1	...	...	...	...	...	...	...	...	...	...	.....	...	.....	.....	.....	.....	.....	.....	1	1	5	.....	1	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....
10	Sept. 3	...	...	...	...	...	...	...	...	...	...	.....	...	.....	.....	.....	.....	.....	.....	1	1	.....	.....	.....	1	2	.....	.....	.....	1	1	1	1	.....	.....	.....	.....	1

PLAT 2. DUSTED ONCE.

10	Aug. 15	...	...	...	2	...	...	...	...	1	2	.....	.....	1	2	1	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
10	Aug. 16	...	2	...	...	...	2	1	...	1	...	.....	.....	.....	1	1	.....	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
10	Aug. 18	1	...	...	...	...	...	...	...	...	5	.....	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	1	.....	.....
10	Aug. 20	...	...	...	...	...	...	1	...	...	1	.....	.....	.....	1	1	2	1	2	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
10	Aug. 23	...	...	...	...	...	...	...	...	2	...	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	1	.....	1	.....	.....	.....	.....	.....	4
10	Aug. 26	...	...	...	...	...	...	...	...	...	...	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	1	.....	2	1	.....	.....	.....	.....	5
10	Aug. 29	...	...	...	...	...	...	...	...	...	...	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	10
10	Aug. 31	...	...	...	...	...	...	...	...	...	...	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	1	.....	1	.....	.....	.....	1	1	.....	.....	.....	.....	.....	2	.....	.....	3
10	Sept. 2	...	...	...	...	...	...	...	...	...	...	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	9

PLAT 3. NO TREATMENT—CHECK.

10	Aug. 15	...	...	...	...	...	...	...	...	...	...	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	9
10	Aug. 16	...	...	...	...	...	...	...	...	...	...	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	10
10	Aug. 18	...	...	...	...	...	...	...	...	...	...	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	2	.....	.....	6
10	Aug. 20	...	...	...	...	...	...	...	...	...	...	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	10
10	Aug. 23	...	...	...	...	...	...	...	...	...	...	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	10
10	Aug. 26	...	...	...	...	...	...	...	...	...	...	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	10
10	Aug. 29	...	...	...	...	...	...	...	...	...	...	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	10
10	Aug. 31	...	...	...	...	...	...	...	...	...	...	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	10
10	Sept. 2	...	...	...	...	...	...	...	...	...	...	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	10

Table 6 shows that all but one of the 90 beetles collected from plat 1, which received two applications of dust, died before September 24, when the work was closed; 31 of the 90 collected from plat 2, which received one application of dust, were alive on September 24; of the 90 beetles collected from plat 3, which received no treatment, only 5 had died by the time the work was closed. One of these was killed by a spider and one by a fungus, leaving only 3 that died from unknown causes.

The dust apparently loses its effectiveness on the trees after about two weeks. In that time it perhaps is either blown off or washed off, or has become so diluted as to be ineffective. This view is confirmed by the fact that most of the beetles from plat 2 remaining alive in jars on September 24, when the work was closed, were collected after the dust had been applied two weeks. On plat 1, where the second application was made 12 days after the first, the dust was nearly 100 per cent effective in killing the confined curculios.

Table 7 gives the percentages of curculios remaining alive on September 24, when all jars were closed.

TABLE 7.—*Percentage of confined curculios alive at close of experiment, 1921.*

PLAT 1. DUSTED TWICE.

Number of beetles.	Date collected.	Number September 24.		Per cent September 24.	
		Alive.	Dead.	Alive.	Dead.
		Number.	*Number.*	*Per cent.*	*Per cent.*
10	Aug. 15	0	10	0	100
10	Aug. 17	0	10	0	100
10	Aug. 19	0	10	0	100
10	Aug. 22	0	10	0	100
10	Aug. 24	0	10	0	100
10	Aug. 27	0	10	0	100
10	Aug. 30	0	10	0	100
10	Sept. 1	0	10	0	100
10	Sept. 3	1	9	10	90

PLAT 2. DUSTED ONCE.

10	Aug. 15	0	10	0	100
10	Aug. 16	0	10	0	100
10	Aug. 18	0	10	0	100
10	Aug. 20	0	10	0	100
10	Aug. 23	4	6	40	60
10	Aug. 26	5	5	50	50
10	Aug. 29	10	0	100	0
10	Aug. 31	3	7	30	70
10	Sept. 3	9	1	90	10

PLAT 3. NO TREATMENT.

10	Aug. 15	9	1	90	10
10	Aug. 16	10	0	100	0
10	Aug. 18	6	4	60	40
10	Aug. 20	10	0	100	0
10	Aug. 23	10	0	100	0
10	Aug. 26	10	0	100	0
10	Aug. 29	10	0	100	0
10	Aug. 31	10	0	100	0
10	Sept. 2	10	0	100	0

The percentage mortality to September 24 of all beetles confined from plat 1 was 98.89 per cent, from plat 2, 65.56 per cent, and from plat 3, 5.56 per cent.

OTHER FIELD AND INSECTARY OBSERVATIONS IN 1921.

Frequently trees other than those selected for records were jarred in the several plats to obtain additional information on the effectiveness of post-harvest dusting. On August 23, 46 curculios were collected from one large tree in the untreated plat. Only about 5 or 6 beetles per tree were taken from the dusted plats at that time.

Many fresh-looking beetles were caught daily, some of them soft and reddish in color, indicating new second-generation adults. Very often more than 10 per cent of the beetles collected showed indications of having recently emerged. An emergence as heavy as this would tend to keep a continued supply of curculios on even the dusted trees, as the poison usually does not kill the beetles in less time than from four to six days.

Many attempts were made throughout the season to observe the beetles feeding in the orchard, but only the results of their work on the foliage could be found. Frequently the beetles confined in battery jars in the insectary were observed feeding on foliage, especially on that not dusted. This feeding took place mostly at night. Their feeding is very characteristic, producing irregular holes, which might be started above or below on any portion of the leaf. (Pl. II, fig. 2.) These holes vary in size from that of a pinhead to a quarter of an inch in diameter. The tender foliage of the new growth is preferred to the fully matured foliage, but often they feed on the older leaves. A considerable amount of feeding is done on the glands at the base of the leaves. Dusted foliage does not appear to be palatable to the beetles, and very little feeding is done on it, even though it be the only food available. The dust apparently has some repellent action. When poisoned foliage is taken as food, the type of feeding is similar to that on untreated foliage.

RESULTS OF EXPERIMENTS AT FORT VALLEY, GA., IN 1922.

The 1922 post-harvest experiments were conducted in a 6-year-old Uneeda orchard. This work was begun, as in former years, about four weeks after the last varieties had been harvested in the vicinity. In the work in 1922 both dust and liquid spray were used, to determine their killing effects on the beetles when they were forced to feed on the foliage after the fruit had been harvested. The orchard contained 1,600 trees, which were divided into four blocks of approximately 400 trees each. Plat 1 was used as a check, receiving no treatment during the experiment; plat 2 was sprayed once; plat 3 was sprayed twice; and plat 4 was dusted twice. This orchard was near the one used for the post-harvest work in 1921, and the curculio hibernating quarters and the conditions for breeding were similar. A ditch ran along one side of all plats and there was a wooded area about 300 yards away. The trees were in good foliage at the beginning of the experiment. However, the beetles were not as numerous as they were in the orchard used for the work the previous year.

The methods used in obtaining results on the effectiveness of the different treatments in 1921 were used in 1922. (See fig. 3.)

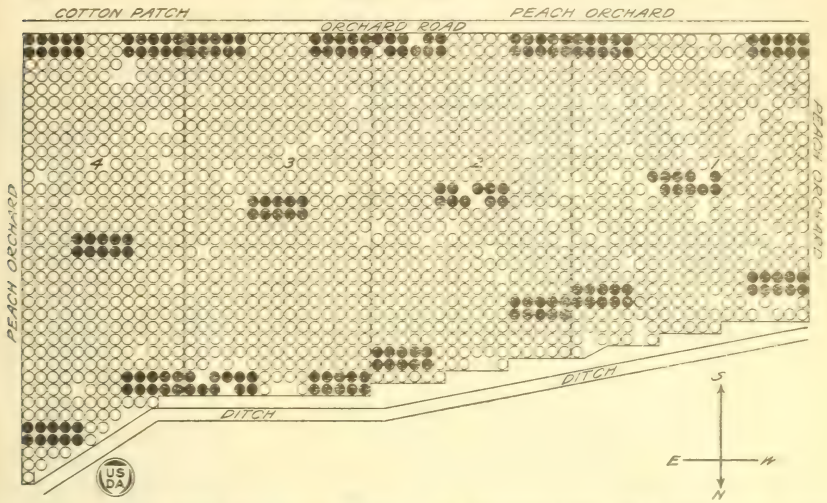

FIG. 3.—After-harvest work, Fort Valley, Ga., 1922. Plat 1, untreated trees; plat 2, sprayed once; plat 3, sprayed twice; plat 4, dusted trees. Solid black circles indicate the jarred trees.

JARRING BEFORE TREATMENT.

Each plat was jarred twice before either the spray or the dust was applied. Table 8 gives the number of beetles caught before treatment.

TABLE 8.—*Number of curculios collected before treatment, 1922.*

Date.	Plat 1.	Plat 2.	Plat 3.	Plat 4.
	Beetles.	*Beetles.*	*Beetles.*	*Beetles.*
Aug. 1	12	33		
Aug. 2			4	22
Aug. 3	16	33		
Aug. 4			9	28
Total	28	66	13	50
Average per tree	0.28	0.66	0.13	0.50

SPRAYING AND DUSTING IN 1922.

Plat 1 was left untreated throughout the experiment as a check. Plat 2 was sprayed August 7, which was about four weeks after the latest varieties had been harvested, and nine weeks after the harvest of the Uneedas. The materials used were 4 pounds of powdered arsenate of lead, 12 pounds of rock lime, and 1½ pounds of calcium caseinate to each 200 gallons of water. This plat received only one application.

Plat 3 was sprayed August 8 and August 21 with the same materials as used on plat 2. Over a gallon per tree was used for the first application, but because of the severe burning and defoliation less than one-half gallon per tree was used in the second spraying on this plat. While the liquid spraying proved satisfactory in killing

off the adult curculios after harvest, it can not be recommended, as very severe burning, causing abnormal defoliation, occurs when post-harvest spraying is practiced after the liquid spray schedule has been carried through during the growing season of the fruit to protect it from pests.

Plat 4 was dusted August 8 and August 21 with 90 per cent hydrated lime and 10 per cent powdered arsenate of lead. About one-fifth of a pound per tree was used for each post-harvest dusting, and the cost per application was about the same as in 1921.

JARRING AFTER TREATMENT.

Table 9 gives the number of beetles collected on each plat after treating with spray or dust.

TABLE 9.—*Number of curculios collected after treatment, 1922.*

Date.	Plat.				Date.	Plat.			
	1	2	3	4		1	2	3	4
	Beetles.	*Beetles.*	*Beetles.*	*Beetles.*		*Beetles.*	*Beetles.*	*Beetles.*	*Beetles.*
Aug. 9	18	22			Aug. 24	16	22		
Aug. 10			17	17	Aug. 25			1	16
Aug. 11	15	17			Aug. 26	12	10		
Aug. 12			3	10	Aug. 28			2	17
Aug. 14	17	16			Aug. 29	25	15		
Aug. 15			11	11	Aug. 30			1	4
Aug. 16	22	21			Aug. 31	17	13		
Aug. 17			4	16	Sept. 1			0	6
Aug. 18	14	20			Sept. 2	26	21		
Aug. 19			8	8					
Aug. 22	11	35			Total	193	212	54	112
Aug. 23			7	7	Average per tree	0.35	0.39	0.11	0.22

By comparing with the collections made before the treatments it will be found that there was an increase in the number of beetles on the untreated plat, and a decrease on the sprayed and dusted plats. Table 10 gives the average number of beetles per tree collected before and after treatment.

TABLE 10.—*Average number of beetles per tree collected before and after treatment, 1922.*

Plat No.	Treatment.	Before treatment.	After treatment.	Increase or decrease.
		Beetle.	*Beetle.*	*Beetle.*
1	Not treated	0.28	0.35	0.07
2	Sprayed once	.66	.39	.27
3	Sprayed twice	.13	.11	.02
4	Dusted twice	.50	.22	.28

Plat 1 increased 0.07 beetle per tree during the course of the experiment; plat 2 decreased 0.27 beetle per tree; plat 3 decreased 0.02 beetle per tree, and plat 4 decreased 0.28 beetle per tree. There were very few beetles on plat 3 before the treatments, and the two liquid sprays used on this plat, after it had received the applications of the regular spray schedule while the fruit was on the trees, practically defoliated it. There was very little poisoned foliage available

for food on this plat, and as a consequence the number of beetles collected every other day from this plat remained about the same

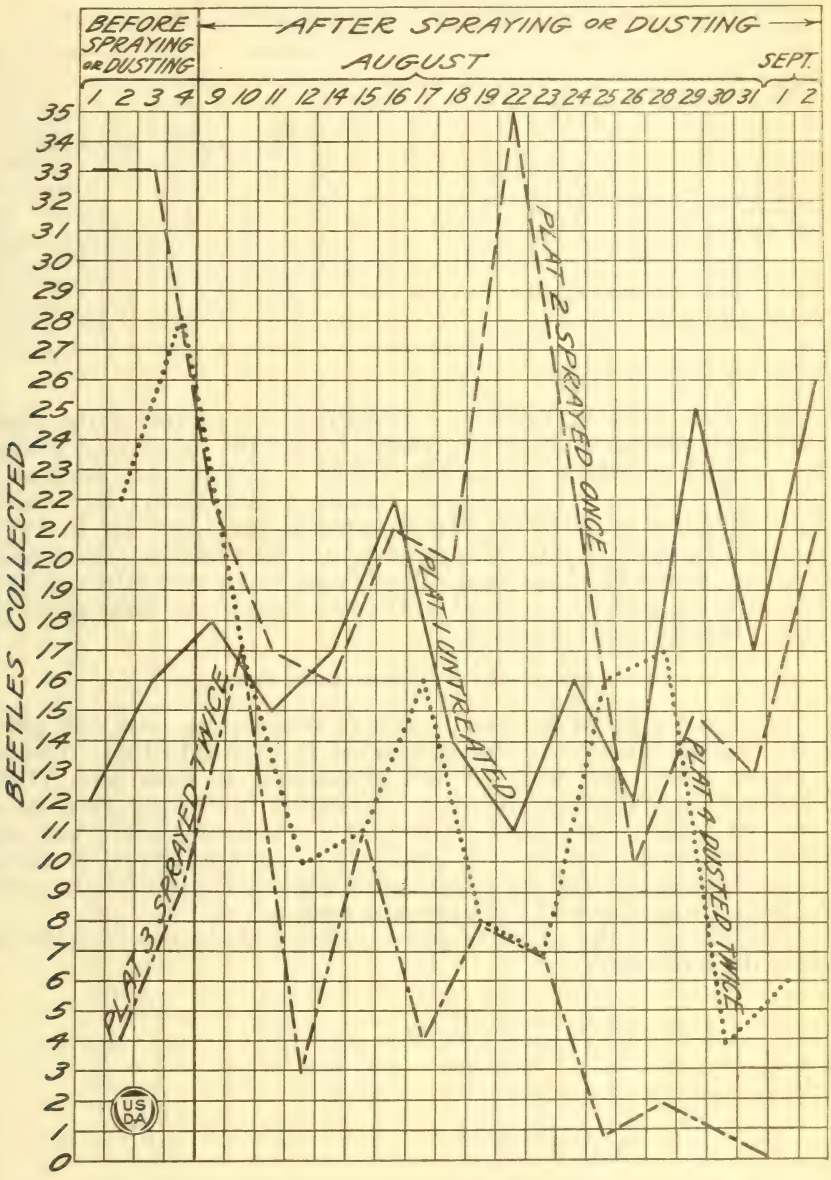

FIG. 4.—Number of plum curculios collected on treated and untreated plats, 1922.

throughout the experiment. (See fig. 4 for graphic comparison of the infestation on the four plats.)

Table 11 gives the summary of results of the field experiments in 1922.

TABLE 11.—*Summary of results from post-harvest spraying and dusting, 1922.*

Period.	Beetles per tree.			
	Plat 1 (check).	Plat 2 (sprayed once).	Plat 3 (sprayed twice).	Plat 4 (dusted twice).
Before treatment	0.28	0.66	0.13	0.50
After treatment	.35	.39	.11	.22
Increase or decrease	[1].07	.27	.02	.28
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Per cent of increase or decrease	[1] 25	40.91	15.38	56

[1] Increase.

The data given in Table 11 substantiate the results of the post-harvest experiments of former years in that the number of beetles increased on the check plat and decreased on the sprayed and dusted plats. Post-harvest spraying or dusting would hardly have been an economical practice for the commercial peach grower in 1922, because the curculio infestation was light. Post-harvest treatments, however, would be of material value in case of a heavy infestation of the curculio, such as occurred in Georgia during the three previous years, 1919 to 1921, inclusive.

RESULTS OF INSECTARY WORK IN 1922.

The same type of insectary work in conjunction with the post-harvest field experiments was conducted in 1922 as in 1921. Thirty-six jars were used, with 10 beetles confined in each jar. These beetles were taken from the daily collections from the several plats between August 9 and September 1 for mortality records. Ten jars each were used for plats 1, 2, and 4, but only six for plat 3, owing to the fact that after the second spraying not enough beetles were collected from this plat for insectary tests.

Table 12 gives the record of daily mortality of the beetles collected from the four plats.

TABLE 12.—*Mortality of confined curculios fed peach foliage from experimental plats, 1922.*

PLAT 1. UNTREATED.

Number of beetles.	Date collected.	Number that died.																														Number living Sept. 16.
		Aug. 12.	Aug. 13.	Aug. 14.	Aug. 15.	Aug. 16.	Aug. 17.	Aug. 18.	Aug. 19.	Aug. 20.	Aug. 21.	Aug. 22.	Aug. 23.	Aug. 24.	Aug. 25.	Aug. 26.	Aug. 27.	Aug. 28.	Aug. 29.	Aug. 30.	Aug. 31.	Sept. 1.	Sept. 2.	Sept. 3.	Sept. 4.	Sept. 5.	Sept. 6.	Sept. 7.	Sept. 8.	Sept. 9.	Sept. 10.	Sept. 11.	Sept. 12.	Sept. 13.	Sept. 14.	Sept. 15.	
10	Aug. 9																																		10
10	11										1			1								1														7
10	14																																		10
10	16																			1		1													8
10	18																																		10
10	22																								1										9
10	24																																		10
10	26																																		10
10	29																										1								9
10	31																																		10

PLAT 2. SPRAYED ONCE.

Number of beetles.	Date collected.	Number that died.																														Number living Sept. 16.
		Aug. 12.	Aug. 13.	Aug. 14.	Aug. 15.	Aug. 16.	Aug. 17.	Aug. 18.	Aug. 19.	Aug. 20.	Aug. 21.	Aug. 22.	Aug. 23.	Aug. 24.	Aug. 25.	Aug. 26.	Aug. 27.	Aug. 28.	Aug. 29.	Aug. 30.	Aug. 31.	Sept. 1.	Sept. 2.	Sept. 3.	Sept. 4.	Sept. 5.	Sept. 6.	Sept. 7.	Sept. 8.	Sept. 9.	Sept. 10.	Sept. 11.	Sept. 12.	Sept. 13.	Sept. 14.	Sept. 15.	
10	Aug. 9	2		1		1	1			1	2																								2
10	11			1			2	1		1	1	1	1			2																			
10	14						1	1		3	2					1				1												1			
10	16								1	1		1	2	1	2			1							1										
10	18										2		1		1		1	1	2	1			1												
10	22																2	1					3	2	2										
10	24																1				1		2			2	1	1	1			1				
10	26																2	1		1	1					1					1		1		
10	29																						1	1	2								1		
10	31																																		

PLAT 3. SPRAYED TWICE.

Number of beetles.	Date collected.	Number that died.																														Number living Sept. 16.
		Aug. 12.	Aug. 13.	Aug. 14.	Aug. 15.	Aug. 16.	Aug. 17.	Aug. 18.	Aug. 19.	Aug. 20.	Aug. 21.	Aug. 22.	Aug. 23.	Aug. 24.	Aug. 25.	Aug. 26.	Aug. 27.	Aug. 28.	Aug. 29.	Aug. 30.	Aug. 31.	Sept. 1.	Sept. 2.	Sept. 3.	Sept. 4.	Sept. 5.	Sept. 6.	Sept. 7.	Sept. 8.	Sept. 9.	Sept. 10.	Sept. 11.	Sept. 12.	Sept. 13.	Sept. 14.	Sept. 15.	
10	Aug. 10					1	1		1					1	1				1		1										1				2
10	12				1	1	1		2	1				1	1			1	1																
10	15						1	1	1	1	1	1			1								2	1												
10	17								1	1		1	1				1			1	1					1		1		1						1
10	19										2			1	2	2									2						1				
10	23																	1				1				1	2			1	1			1	12

TABLE 12.—*Mortality of confined curculios fed peach foliage from experimental plats, 1922*—Continued.

PLAT 4. DUSTED TWICE.

Number of beetles.	Date collected.	Number that died.																																Number living Sept. 16.
		Aug. 12.	Aug. 13.	Aug. 14.	Aug. 15.	Aug. 16.	Aug. 17.	Aug. 18.	Aug. 19.	Aug. 20.	Aug. 21.	Aug. 22.	Aug. 23.	Aug. 24.	Aug. 25.	Aug. 26.	Aug. 27.	Aug. 28.	Aug. 29.	Aug. 30.	Aug. 31.	Sept. 1.	Sept. 2.	Sept. 3.	Sept. 4.	Sept. 5.	Sept. 6.	Sept. 7.	Sept. 8.	Sept. 9.	Sept. 10.	Sept. 11.	Sept. 12.	Sept. 13.	Sept. 14.	Sept. 15.	
10....	Aug. 10	....	....	1	1	....	1	1	....	....	....	....	....	2	....	....	....	1	....	....	1	2	....	....	....	....	....	....	....	....	....	....	....	....	....	....
10....	12	....	....	1	....	....	1	1	....	1	1	1	2	....	....	2	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
10....	15	....	....	....	....	....	....	....	....	2	....	....	....	....	1	....	1	1	....	2	....	....	....	....	1	....	....	....	....	....	....	1	....	....	....	....	1
10....	17	....	....	....	....	....	....	....	....	....	1	1	1	1	1	2	2	....	....	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
10....	19	....	....	....	....	....	....	....	....	....	....	1	....	....	....	....	1	....	1	1	....	1	1	3	....	....	....	....	....	....	....	....	....	....	....	....	....
10....	23	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1	....	1	....	1	1	2	4	....	....	....	....	....	....	....	....	....	....	....	....	....
10....	25	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1	1	....	1	3	....	1	3	....	....	....	1	....	....	....	....	....	....	....
10....	28	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1	1	1	2	....	1	....	1	1	2	....	....	....	....	2
10....	30	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	2	....	1	....	1	1	1	....	....	1	....	....	....
10....	Sept. 1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1	....	....	....	....	....	....	....	....	....

The data given in Table 12 show that the mortality of confined curculios was greater on the plat that was dusted twice than on that sprayed once or on the untreated plat. Plat 1, untreated, showed a mortality of 7 per cent, plat 2, sprayed once, showed a mortality of 81 per cent, plat 3, sprayed twice, showed a mortality of 91.67 per cent. This last percentage, however, should not be considered in comparison with the others, as only 60 beetles could be obtained for the test on this plat, and, furthermore, two sprayings resulted in an almost complete defoliation. Plat 4, dusted twice, showed a mortality of 87 per cent.

GENERAL SUMMARY.

Post-harvest spraying and dusting decreased the number of beetles per plat. The chief benefit from this work, however, lies in preventing the rapid increase of second-generation adults, which are emerging in numbers at that season of the year. The untreated plats show a marked increase in second-generation adults after harvest.

In 1921 two post-harvest dustings decreased the number of beetles 6 per cent, whereas on the check plat during the same period there was an increase of 69.53 per cent. In 1922 one post-harvest application of spray decreased the beetles 40.91 per cent and two dustings decreased the beetles 56 per cent, whereas during the same period there was an increase of 25 per cent on the check or untreated block.

Mortality tests conducted in the insectary show that the dust is not effective after a period of two weeks. In 1921 there was a mortality of 98.89 per cent of the beetles confined from the plat that was dusted twice; a 65.56 per cent mortality from those collected from the plat dusted once, and only a 5.56 per cent mortality from those collected from the check or untreated plat. In 1922 there was a mortality of from 87 per cent to 91.67 per cent of the beetles confined from the plats that were dusted or sprayed twice, an 81 per cent mortality from those collected from the plat sprayed once, and only a 7 per cent mortality from those collected from the check or untreated plat.

Two applications are necessary for best results in controlling the curculio after harvest, making the first four weeks after the harvest of the latest variety of peaches and the second two weeks later.

Post-harvest treatments are not advisable except in cases where the curculio infestation has been severe during the peach season.

Post-harvest liquid spraying after the usual liquid spray schedule had been followed earlier in the season on the fruit resulted in severe burning of the foliage. Two post-harvest applications of a 10 per cent arsenate of lead and 90 per cent hydrated lime dust can be used with safety, and are recommended in cases where the curculio has been bad.

In dusting peach trees after harvest for the curculio this dust should be used at the rate of about one-fifth of a pound per tree. When used at that rate the dust can be applied for about three-fourths of a cent per tree for each application.

RECOMMENDATIONS.

The results of the post-harvest experiments conducted in Georgia in 1921 and 1922, which are substantiated by the results of similar experiments in Mississippi in 1919 and 1920, show that many adult curculios can be killed before they go into hibernation by applying arsenate of lead. Where the curculio infestation during the peach season has been severe, post-harvest applications of arsenate of lead are profitable, because of the protection given the next peach crop by reducing the number of beetles in the fall before they go into hibernation and while they are forced to feed on the peach foliage. Ten per cent arsenate of lead and 90 per cent hydrated lime dust should be used for this work, making the first treatment four weeks after the harvest of the last variety of peaches, followed by a second application two weeks later. The first application should not be made sooner than four weeks after harvest, as the curculio does considerable feeding for several weeks following the harvest on the peach fruits left in the orchard.

ORGANIZATION OF THE UNITED STATES DEPARTMENT OF AGRICULTURE.

November 20, 1923.

Secretary of Agriculture..... HENRY C. WALLACE.
Assistant Secretary..... HOWARD M. GORE.
Director of Scientific Work..... E. D. BALL.
Director of Regulatory Work..... WALTER G. CAMPBELL.
Director of Extension Work..... C. W. WARBURTON.
Weather Bureau..... CHARLES F. MARVIN, *Chief.*
Bureau of Agricultural Economics..... HENRY C. TAYLOR, *Chief.*
Bureau of Animal Industry..... JOHN R. MOHLER, *Chief.*
Bureau of Plant Industry..... WILLIAM A. TAYLOR, *Chief.*
Forest Service..... W. B. GREELEY, *Chief.*
Bureau of Chemistry..... C. A. BROWNE, *Chief.*
Bureau of Soils..... MILTON WHITNEY, *Chief.*
Bureau of Entomology..... L. O. HOWARD, *Chief.*
Bureau of Biological Survey..... E. W. NELSON, *Chief.*
Bureau of Public Roads..... THOMAS H. MACDONALD, *Chief.*
Bureau of Home Economics..... LOUISE STANLEY, *Chief.*
Fixed Nitrogen Research Laboratory..... F. G. COTTRELL, *Director.*
Division of Accounts and Disbursements..... A. ZAPPONE, *Chief.*
Library..... CLARIBEL R. BARNETT, *Librarian.*
Federal Horticultural Board..... C. L. MARLATT, *Chairman.*
Insecticide and Fungicide Board..... J. K. HAYWOOD, *Chairman.*
Packers and Stockyards Administration, *Grain Future Trading Act Administration*..... CHESTER MORRILL, *Assistant to the Secretary.*
Office of the Solicitor..... R. W. WILLIAMS, *Solicitor.*

This bulletin is a contribution from

Bureau of Entomology..... L. O. HOWARD, *Chief.*
Fruit Insect Investigations..... A. L. QUAINTANCE, *Entomologist in Charge.*

19

ADDITIONAL COPIES
OF THIS PUBLICATION MAY BE PROCURED FROM
THE SUPERINTENDENT OF DOCUMENTS
GOVERNMENT PRINTING OFFICE
WASHINGTON, D. C.
AT
5 CENTS PER COPY

▽